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*THE LAWS OF NATURE.**

WE say that nature is unchanging, and so perhaps it is, in the eye of some eternal being, but not in ours, for the things that we see from day to day, appear permanent only by comparison with the duration of our own brief life, and our own little experience.

An inhabitant of the land where nature has just passed through such an awful convulsion, with a loss of life greater for so short a time than history has ever recorded, might have said in the morning that nature never changes, because it had never changed in his own little experience; but he would not have said so at that day's close. Now the experience of the entire human race is far briefer relative to nature's duration than that of one of these islanders who knew the green mountain with its fresh lakes only as a place of quiet rest, up to the moment when the gates of hell were opened under it.

Nature, then, really changes, and would apparently do so if man were not here; for it is not man's varying thoughts about nature that make her change. But there is something quite different which does change because of man, and which apparently would not change if he were not here. This is what he calls the 'laws of nature.'

* A paper read before the Philosophical Society of Washington, May 10, 1902.

The assumption that there are such things is due to him, and such 'laws' are known only through his mind, in which alone nature is seen.

It is perhaps a hard saying to most that there are no such things as 'laws of nature'; but this is the theme on which I have to speak.

These, then, are the laws of man's own mind, or the effects of his own mind, which he projects outside of himself and imagines to be due to some permanent and unalterable cause having an independent existence. This is not only because his season for observation is but a moment in the passage of nature's eternal year, and because with his pathetic sense of his own weakness he would gladly stay himself on the word of some unchanging being. It is because this sense of dependence is strangely joined with such self-conceit that when he listens to what he himself says he calls it the voice of God. From these twin causes, arising both from his inability as a creature of time to observe nature, which is eternal, and again from his own overweening sense of his own capacity to know her, he looks for some immutable being whom he believes to have written his own ideas in what he calls 'the book of nature.'

I am not questioning the existence of such a being as the 'Author of Nature'; but asking if such a volume as is imputed to him, ever really existed. The very phrase, 'book of nature,' is a legacy from moribund mediæval notions of a lawgiver; and it, with the vitality of words which carry to us dying ideas, has lived on to our own time, when we can no longer believe it in our hearts, although it is still upon our lips.

To convince ourselves, we need only pause a moment to ask the simple question whether there is any authority who has prepared such a clearly written book of statutes in which we can really read nature's laws.

The question answers itself.

I repeat that I am not denying here the existence of such a being as the imputed author of these laws, but say that, ignorant as we are of what is being done by him, we cannot read his thoughts in our momentary vision of what is forever passing.

'For my thoughts are not your thoughts, neither are your ways my ways, saith the Lord' is a caution which, whether believers or not, it would not harm us to consider; and when we say that these 'thoughts' are written in 'the book of nature,' this cannot mean that they are legible there as in a statute book where he who runs may read. If nature is to be compared to a book at all, it is to a book in the hands of an infant to whom it conveys little meaning, for such are we; or rather it is like a 'book of celestial hieroglyphs, of which even prophets are happy that they can read here a line and there a line.'

I hope what I am trying to say may not bear the appearance of some metaphysical refinement on common sense. It is common sense that is intended, and the 'laws of nature' that seem to me a metaphysical phrase.

To decorate our own guesses at nature's meaning with the name 'laws of nature' is a presumption due to our own feeble human nature, which we can forgive for demanding something more permanent than itself, but which also leads us to have such an exalted conceit of our own opinions as to hide from ourselves that it is these very opinions which we call nature's laws.

The history of the past shows that once most philosophers, even atheists, thus regarded the 'Laws of Nature,' not as their own interpretations of her, but as something external to themselves, as entities partaking the attributes of Deity—entities

which they deified in print with capital letters—as we sometimes do still, though these 'Laws' now are shorn of 'the glories of their birth and state' which they once wore, and are not turning out to be 'substantial things.'

But are there not really things (like the fact of gravitation, for instance) external to ourselves, which would exist whether we were here or not, and which are part of the order of nature? Apparently, yes, but part of the *laws* of nature no!

The phrase even yet exercises a wide influence, though it has seemed to me that a significant change is taking place in the leaders of common opinion with regard to the meaning that the words convey.

I presume that the greater proportion of us here are interested in science. I may indeed assume that we all are; and I want to inquire what lesson for us, as students of nature, there lies in the fact that we are no longer impressed by her 'laws' as were the scientific men of a former generation.

It is convenient to measure the distance we have passed over, by the fact that one hundred and fifty years ago, one of the acutest of reasoners, David Hume, published a still celebrated argument against miracles, which within my own recollection was held to be so formidable that those who were reluctant to believe in his conclusions, were still unable to offer a good refutation. The immense number of attempted refutations and their contradictory character are perhaps the best testimony for this.

Hume defines a miracle as a violation of the 'laws of nature,' and his argument, concisely stated, is that there must 'be a uniform experience against every miraculous event, otherwise the event would not merit that appellation, and as a uniform experience amounts to a proof, there is here a direct and full proof from the nature of the fact against the existence of any miracle.'

Now while his argument is logically as conclusive as ever, it to-day convinces only those who are anxious to accept its conclusion.

What is the reason for this great change?

We may ask what the laws of nature really are, and pass from what they were thought to be by Hume to what they are beginning to be understood to be by us, without here inquiring into the intermediate steps which brought the change about.

It seems to me that the argument which was conclusive not merely to the learned, but to the common cultivated thought of Hume's time has never been expressly refuted when its premises were admitted (and the generation following him admitted them); and yet this compelling argument, as it once seemed, is gradually losing its force to most minds, not through counter argument, but by an insensible change of opinion in the attitude of the thinking part of our public, as compared with his, a change about certain fundamental assumptions on which the argument rested, and from his own views of the universe to those we are beginning to take.

In the first place, the immensely greater number of things we know in almost every department of science beyond those which were known one hundred and fifty years ago, has had an effect which doubtless could have been anticipated, but yet which we may not have wholly expected. It is, that the more we know, the more we recognize our ignorance, and the more we have a sense of the mystery of the universe and the limitations of our knowledge.

I believe it may be said that, if not to Hume, at any rate to the majority of those about him, and to his later contemporaries, there was very much less mystery in the world than we see in it, and if it were then still occasionally said that there were

'things in heaven and earth not dreamt of in 'their' philosophy,' these words must have struck on the self-complacent minds of his generation as something to be tolerated as poetic license, rather than as accurate in philosophic meaning. Compared with ours, that whole century was satisfied with itself and its knowledge of the infinite, and content in its happy belief that it knew nearly everything that was really worth knowing. This 'nearly everything' which it thought it knew about the universe, it called the 'laws of nature.'

It was to this belief in the general mind, I think, that the success of Hume's argument was due.

The present generation has begun, if not to be modest or humble, to be somewhat less arrogant in the assumption of its knowledge. We are perhaps beginning to understand, not in a purely poetical sense, but in a very real one, that there may be all around us in heaven and earth, things beyond measure, of which 'philosophy' not only knows nothing, but has not dreamed.

As a consequence of this, there is growing to be an unspoken, rather than clearly formulated, admission that we know little of the order of nature, and nothing at all of the 'laws' of nature.

Now if we are at present at least, disposed to speak of an observed 'order' of nature (not carrying with it the implication of necessity denoted by 'law'), I think we have some reason to say that there is a prescience of a change in common thought about this matter, and that it is owing to this that we are coming to be where we are.

I do not know that there is a less wide belief in the gospel miracles in our day, but if it were so, the decline in the weight given Hume's argument is not due solely to that, for it may surely be said that it was not merely an argument against gospel miracles, but against all the prodigies to be found in history, sacred and profane, where he doubtless had in mind traditions of stones falling out of heaven, cures wrought by psychological agency, and the like, all 'superstitions' to the men of his day. These if they no longer believed in a deity, were none the less shocked by the culpable existence of such vulgar beliefs in conflict with the deified 'laws of nature,' while such 'superstitions' have in our day become subjects of modest inquiry.

Let me quote from a later writer, whose point of view is singularly different from that of Hume and his contemporaries, and who in answer to the question, 'What is a miracle?' begins by reminding us that the reply will depend very much upon the intelligence of the being who answers it, or whom the miracle is wrought for.

"To my *horse,* do I not work a miracle every time I open for him an impassable turnpike?"

"But is not a real miracle simply a violation of the 'laws of nature'? ask several. What are the laws of nature? Is it not the deepest law of nature that she be constant?" cries the illuminated class; "is not the machine of the universe fixed to move by unalterable rules?"

"I believe that nature, that the universe, which no one whom it so pleases can be prevented from calling a machine, does move by the most unalterable rules. And now I make the old inquiry as to what those same unalterable rules, forming the complete statute-book of nature, may possibly be?

"'They stand written in our works of science,' say you; 'in the accumulated records of man's experience.' Was man with his experience present at the creation, then, to see how it all went on? Have any deepest scientific individuals yet dived down to the foundations of the universe, and gauged everything there? Alas, these scientific individuals have been nowhere

but where we also are; have seen some handbreadths deeper than we see into the deep that is infinite, without bottom as without shore.''

''Philosophy complains that custom has hoodwinked us from the first; that we do everything by custom, even believe by it; that our very axioms, boast as we may, are oftenest simply such beliefs as we have never heard questioned. Innumerable are the illusions of custom, but of all these perhaps the cleverest is her knack of persuading us that the miraculous, by simple repetition, ceases to be miraculous!''

A lesson for us, as people who are most of us interested in science, showing how little its most fixed conclusions may be worth, may perhaps be conveyed in an example. A century and a half ago, when the new science of chemistry won its first triumphs, the fundamental discovery which was to illuminate the whole science, the settled acquisition which it seemed to have brought to us, the thing which was going to last, was 'phlogiston.'

This had everything to recommend it, in universal acceptance, and in what seemed to the foremost men of the time, its absolute certainty.

''If any opinion,'' says Priestley, ''in all the modern doctrine concerning air be well founded, it is certainly this, that nitrous air is highly charged with phlogiston. If I have completely ascertained anything at all relating to air, it is this.''

I am trying here to say that laws of nature are little else than man's hypotheses about nature.

Phlogiston was then to the science of a former age, in this sense a law of nature, at least as great a generalization as the kinetic theory of gases is to us; as widely accepted, as firmly believed and as certainly known—but what has become of it now?

Can we tell, then, in advance by any criterion what a 'law of nature' is?

With a curious begging of the question some answer, 'Yes, for laws of nature have this distinction, that they have never been disproved.' As if one were to say, Yes, because when they *are* disproved we deny that they are laws of nature!

Those of us who are capable of being instructed or warned by the history of human thought may, then, ask what kind of a guarantee are we to have for any other 'fact' of our new knowledge? May they not—all these 'facts'—be gone like the baseless fabric of this vision, before another hundred years are passed?

The physical sciences seem to have had less change in their theories than the mighty displacements in other branches of natural knowledge, but it is a truism to say that all are changed, and it should be a truism to add that the 'laws of nature' are not to us what they were a hundred years ago.

I repeat that of the 'order' of nature we may possibly know a little; but what are these 'laws' of nature? What celestial act of congress fixed them? In what statute book do we read them? What guarantees them? Our mistake is in believing that there is any such thing, apart from our own fallible judgment, for the thing which the 'laws of nature' most absolutely forbid one generation to believe, if it only actually happens, is accepted as a part of them by the succeeding.

Suppose that a century ago, in the year 1802, certain French Academicians, believing like every one else then in the 'laws of nature,' were invited, in the light of the best scientific knowledge of the day, to name the most grotesque and outrageous violation of them which the human mind could conceive. I may suppose them to reply, 'if a cartload of black stones were to tumble out of the blue sky above us, before our eyes, in this very France, we

should call *that* a violation of the laws of nature, indeed!' Yet the next year, not one, but many, cartloads of black stones did tumble out of the blue sky, not in some far off land, but in France itself.

It is of interest to ask what became of the 'laws of nature' after such a terrible blow. The 'laws of nature' were adjusted, and after being enlarged by a little patching, so as to take in the new fact, were found to be just as good as ever! So it is always; when the miracle *has* happened, then and only then it becomes most clear that it was no miracle at all, and that no 'law of nature' has been broken.

Applying the parable to ourselves then, how shall we deal with new 'facts' which are on trial, things perhaps not wholly demonstrated, yet partly plausible? During the very last generation hypnotism was such a violation of natural law. Now it is a part of it. What shall we say, again, about telepathy, which seemed so absurd to most of us a dozen years ago? I do not say there is such a thing now, but I would like to take the occasion to express my feeling that Sir William Crookes, as president of the British Association, took the right, as he took the courageous, course in speaking of it in the terms he did. I might cite other things, the objects of ridicule only a few years ago, of debate now, but which have not all found supporters who possess the courage of their convictions.

The lesson for us in dealing with them is not that we should refuse to believe, on the one hand, and sneer at everything which is on its trial; for this, though a very general and safe procedure, is not the one to be recommended to those of us who have some higher ideal than acquiescence with the current belief.

The lesson for us is that we must not consider that anything is absolutely settled or true.

This is not to say that we are to be blown about by every wind of scientific doctrine. It is to be understood as a practical rule of life, that we must act with the majority where our faith does not compel us to do otherwise; but it seems to me that we must always keep ready for use somewhere; in the background of our mind possibly, but somewhere, the perhaps trite notion that we know nothing absolutely or in its essence; and remember that though trite it is always true, and to be kept as a guide at every turning of the scientific road, when we cannot tell what is coming next.

How many doctrines of our own day will stand the light of the next century? What will they be saying of our doctrine of evolution *then?* I do not know; but let me repeat what I have said elsewhere, that the truths of the scientific church are not dogmas, but something put forward as provisional only, and which her most faithful children are welcome to disprove if they can. I believe that science as a whole is advancing with hitherto unknown rapidity, but that the evidence of this advance is not in reasoning, but in the observation that our doctrine is proving itself, by the fact that through its aid nature obeys us more and more, as I certainly believe it does.

Never let us forget, however, that man, being the servant and interpreter of nature, as Bacon says, can do and understand so much, and so much only, as he has *observed* of the course of nature, and that beyond this he neither knows anything nor can do anything. No walk along 'the high priori road' will take him where he wants to go, and no 'law of nature' will certainly help him.

But these 'laws,' having authority only as far as they are settled by evidence, and by observation alone, it may be a just inquiry as to what constitutes observation, and above all, who judges the evidence. If the kinetic theory of gases, for in-

stance, is a matter of inference rather than of observation, are we sure that we have a better guarantee for it than a previous century had for phlogiston? Our good opinion of ourselves, as compared with our scientific fathers, makes us think we have. I think myself that we have; and yet, remember, it is the same human nature which judged that evidence then, that judges this evidence now, and remember that however rapidly science changes human nature remains very much the same, and always has a good conceit of itself.

While we are venturing to utter truisms, I repeat, let us take once more this one, home to ourselves, that there is a great deal of this 'human nature' even in the best type of the scientific man, and that we of this twentieth century share it with our predecessors, on whom we look pityingly, as our successors will look on us.

Let us repeat, and repeat once more, that though nature be external to ourselves, the so-called 'laws of nature' are from within —laws of our own minds—and a simple product of our human nature. Let us agree that the scientific imagination can suggest questions to put to nature, but not her answers. Let us read Bacon again, and agree with him that we understand only what we have observed. Finally let us add that we never understand even that, in the fullness of its meaning, for remember that of all the so-called laws of nature the most constantly observed and most intimately and personally known to us, are those of life and death—and how much do we know about the meaning of *them?*

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KINETIC EVOLUTION IN MAN.

IN a recent number of SCIENCE Mr. W J McGee has summarized his reasons for holding that anthropological evolution is a process of integration standing in direct contrast to the divergence of biological evolution:

"The great fact attested by all observation on human development, and susceptible of verification in every province and people, is that mankind is not differentiating in either physical or psychical aspects, but are converging, integrating, blending, unifying, both as organisms and as superorganic groups.

"Everywhere the developmental lines converge forward and diverge backward, just as the lines of biotic development diverge forward and converge backward. How this discrepancy is to be removed is a question whose importance increases with every advance in the science of anthropology."*

That human evolution is synthetic appears undeniable, but the discrepancy pointed out by Mr. McGee has been removed in advance by the recognition of the same leading principle in biological evolution. Man is better known than any other animal, and evolutionary theories which do not accommodate this best certified series of biological facts might well have been distrusted. The kinetic factor of synthesis has been neglected because biologists as well as anthropologists have failed to perceive that evolutionary progress is a cause instead of a result of the differentiation of species or varieties, but since evolution must be studied in species an adequate comprehension of the evolutionary phenomena of any specific group should make plain their relation to more general principles.

Isolation and segregation favor constancy in the characters by which systematists are accustomed to distinguish species, but it is as erroneous with other animals as with man to infer from this that isolation conduces to evolutionary

* 'Current Questions in Anthropology,' SCIENCE, N. S., Vol. 14, No. 365, pp. 996 and 997.